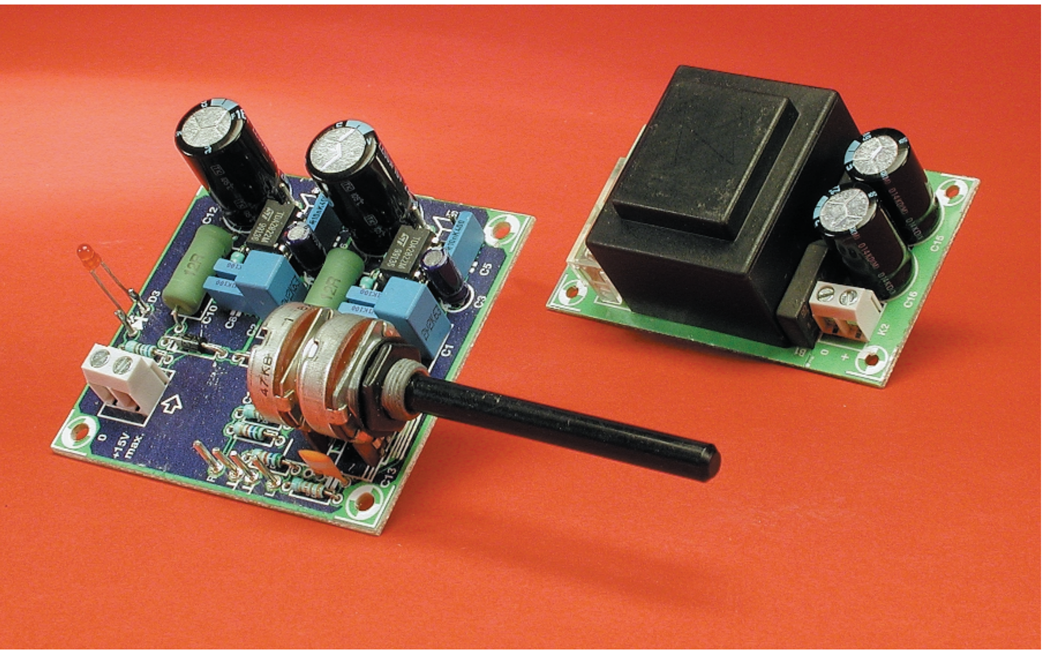
PC Audio Amp

2 x 180 W_{PMPO} Mini Amplifier

By R. Badenhausen

This stereo amplifier uses a low cost, and widely available audio IC. The TDA2822M from ST Microelectronics. With the addition of a few passive components it is possible to build a low cost stereo amplifier featuring a good impulse response, ideally suited for connection to a PC soundcard.



Looking at today's compact active loudspeaker systems for PC's you can only marvel at the quoted power output that such small units can produce. A closer inspection reveals that the power quoted is not the generally accepted and well defined continuous power rating of the amplifier but rather its Peak Music Power Output (P.M.P.O.). This rating gives an indication more of the ability of an amplifier to reproduce impulses rather than its continuous output power rating.

Big reservoirs are best

Most amplifiers with a good impulse response employ large reservoir capacitors in their power supply circuits. Calculation of the *P.M.P.O* (see box) assumes that the conducting output transistor T1 can dump the total charge from the reservoir capacitor into the loudspeaker. In practice, a voltage drop across the transistor means that this is not possible. Moreover, the amplifier will have a minimum operating voltage below which it will cease to function. With many of the low cost PC active speaker systems available on the market, the design of the output stage results in further loss of performance when a capacitor is used between the output transistors and loudspeaker. These are switched in series with the power supply capacitor during conduction and effectively reduce the capacity of the discharge path.

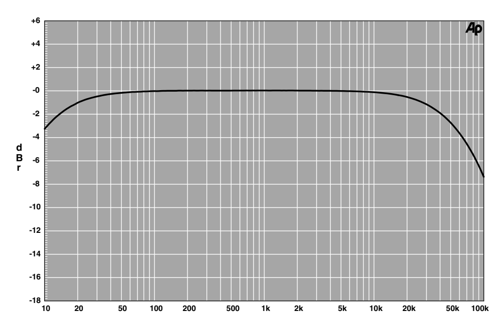
Low Losses

An integrated amplifier was chosen for this design. The output stage exhibits a voltage drop of less than one Volt and according to the data sheet, can work with the supply voltage down at 1.8 V (!). The TDA2822M with its 8 pin mini DIP package outline provides a good solution for a stereo amplifier capable of driving loudspeakers of all the common impedances. **Figure 1** shows the internal circuit of the TDA2822M and also a typical application circuit. The RC network R3/C6 and R4/C7 serve to suppress any tendency to oscillate. This bipolar chip has a fixed voltage gain of

Test results

(1 kHz, 8 Ω, P1 max., both channels loaded and driven)

Sensitivity(1 kHz/500 mW)		120 mV_{eff}
Bandwidth (250 mW)	"cold"	12.5 Hz - 55 kHz
	"hot"	10 Hz - 52 kHz
P_{max} (1 kHz, THD+N = 1 %)		500 mW
THD-N (250 mW, B = 80 kHz)	"cold"	0.16 %
	"hot"	0.9 %
S/N at 500 mW (P1 min., linear 22 Hz - 22 kHz)		77 dB
	(P1 max., linear 22 Hz - 22 kHz)	70 dB
	(P1 min.)	80 dB(A)
	(P1 max.)	78 dB(A)
Channel separation		>65 dB
Quiescent current (both ICs with LED)		43 mA
No load operating voltage		ca. 13 V



Frequency response
(250 mW/8 Ω,
B ≈ 10 Hz - 52 kHz)

40 dB. The quoted distortion is 0.2% with an output power of 0.5 watt at f = 1 kHz and into an 8 Ω load, however during testing (with the IC running hot) this was not achieved. Using the same output impedance and with a output power of 1 W, the data sheet indicates a bandwidth of 120 kHz but again as you can see, we measured a slightly lower value. The TDA2822X family of amplifiers were originally designed to be used in portable audio equipment (Minidisc, Discman, Walkman etc.). The performance data applies across the whole family. An additional advantage of this IC is the simple component selection for loudspeaker impedance matching at a fixed input signal level and operating voltage.

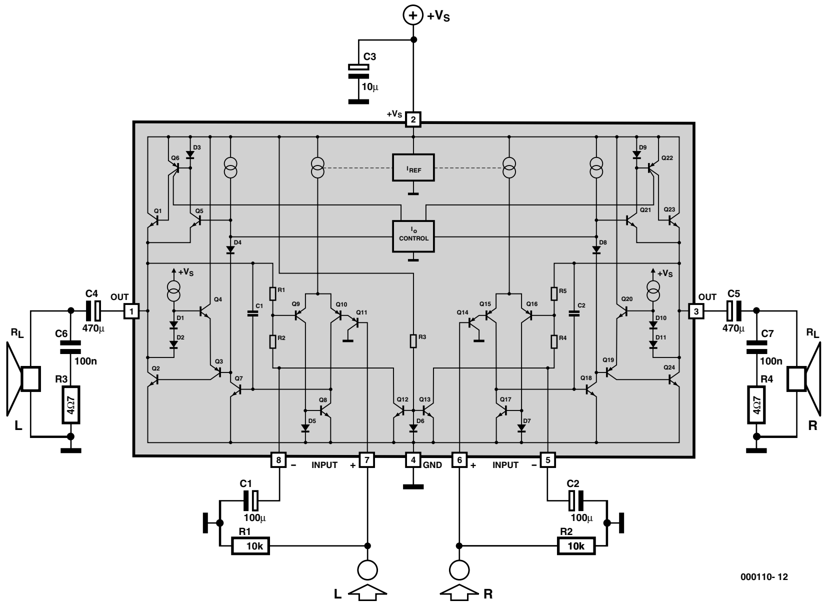


Figure 1. Internal diagram of the TDA2822M and a typical stereo application.

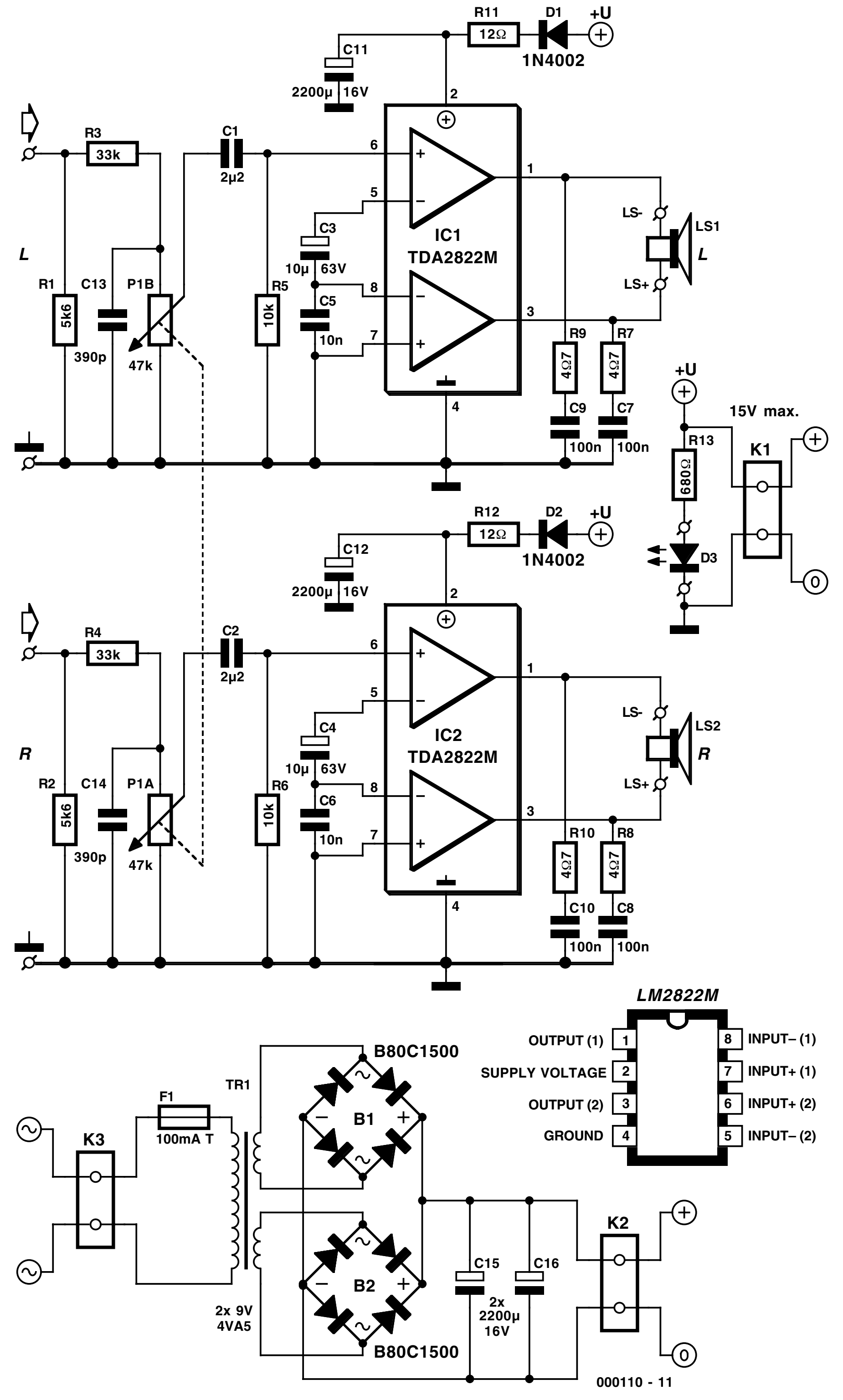
Bridge instead of Stereo

When the output capacitor is omitted from the output stage it is important to ensure that the other end of the speaker is not connected to earth. For this configuration, it is necessary to connect the two amplifiers in the chip in a bridge configuration to provide just one channel (**Figure 2**). A further IC amplifier is then necessary to produce the other half of the stereo amplifier. To optimise the amplifiers impulse response, the circuit does not have any external negative feedback components. The overall gain of the amplifier is set by the input divider (R1 - R4) and the volume control. The use of C3/C4 to couple the inverting inputs is suggested in the data sheet. The polarity of these electrolytic capacitors is not critical because the signal levels here are only in the millivolt range.

Many soundcards offer direct control of the output signal tone via the PC operating system so it was considered unnecessary to provide bass, treble or 3D controls for the amplifier. Between the input network and the tandem volume potentiometer are Anti Aliasing Filters formed by R3/C13 and R4/C14. The value of these filter components is determined by the value of the output load and can be found on **Table 1**. The output offset voltage is guaranteed by the manufacturer to be less than ±50 mV when the amplifier is used in a bridge configuration. The supply voltage to pin 2 has an absolute maximum value of 15 V. The output stage of the IC is not short circuit protected. For this reason it is important not to use a type of socket (e.g. stereo jack socket) which allows the output to be momentarily short-circuited during plugging or unplugging. This style of connector is however fine for the input connections. If you do not have in mind a loudspeaker (or headphones) for this amplifier then it is best to choose the components for the 8 Ω or 16 Ω version. The test results are given for operation into an 8 Ω loudspeaker. The plot shows the frequency response of the amplifier at its operating temperature (hot) driving 250 mW into an 8 Ω load. The bandwidth extends from 10 Hz to 52 kHz.

Heatsink? No Need!

Both channels of the amplifier are built onto a small single sided PCB with an extensive earth area to give good shielding. Component placement is relatively straightforward, it is



COMPONENTS LIST

Resistors:
R1,R2 = 5kΩ6
R3,R4 = 33kΩ
R5,R6 = 10kΩ
R7...R10 = 4Ω7
R11,R12 = 12Ω >2W
R13 = 680Ω
P1 = 47kΩ logarithmic, stereo

Capacitors:
C1,C2 = 2µF2 MKT, raster 5 or 7.5mm
C3,C4 = 10µF 63V radial
C5,C6 = 10nF
C7-C10 = 100nF
C11,C12,C15,C16 = 2200µF 16V radial, dia. ≤12.5 mm
C13,C14 = 390pF

Semiconductors:
D1,D2 = 1N4002
D3 = LED, rot (not high-efficiency)
IC1,IC2 = TDA2822M (8-pin DIP) (ST Microelectronics) (Farnell)

Miscellaneous:
K1,K2 = 2-way PCB terminal block, raster 5mm
K3 = 2-way PCB terminal block, raster 7.5mm
B1,B2 = B80C1500 (80V piv, 1.5A peak) (rectangular case)
TR1 = 2x9 V/4VA5 (e.g., VTR4209 (Monacor/Monarch)
F1 = fuse, 100mA, time lag, with PCB mount holder

Figure 2. The amplification factor of the TDA2822M is controlled by the tandem potentiometer.

only important to ensure that no bridges are formed between tracks during soldering. A bonus of this design is that no heatsink is necessary for the amplifier so you can leave those drills and taps in the toolbox where they belong. Fitting the finished amplifier into a PC should also be straightforward.

If the amplifier is to be fitted inside a PC it is possible to use the +12 V from the power supply unit (PSU) in the PC. In this case it will not be necessary to fit the mains unit part of this design. It is important here to check the earth continuity between the PSU and the soundcard in the PC. To reduce the effects of interference it is advisable to fit the circuit inside a small grounded case, this will ensure that the body of the potentiometer is also grounded.

If the amplifier is to be used externally then the PCB shown in **Figure 3** includes a mains unit. It is a simple matter to fit the mains transformer, two in-line rectifiers, two capacitors and fuse holder.

In both cases the amplifier should be mounted as far as practicable from the power supply.

(000110-1)

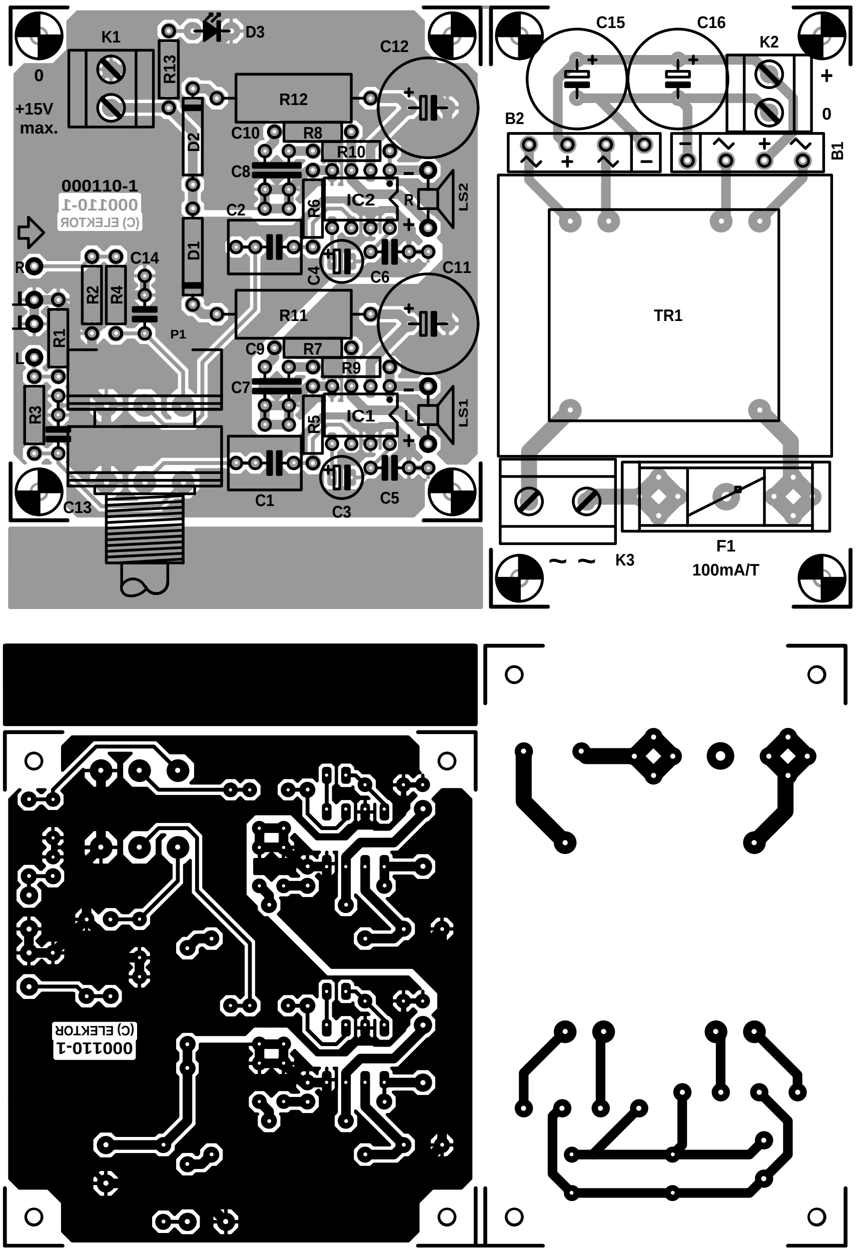
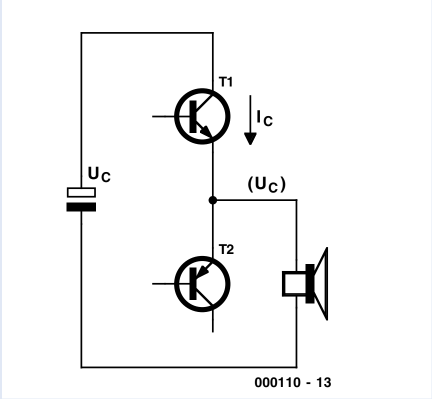


Figure 3. The PCB includes a layout for a mains power unit. Be sure to separate the two halves before the components are fitted. The board is not available ready-made.

Loudspeaker impedance	**4**	**8**	**16**	**32**	**Ω**
R3/R4	47	33	22	15	kΩ
C13/C14	330	390	470	560	pF
R11/R12	15 (2 W)	12 (2 W)	8.2 (1 W)	5.6 (1 W)	Ω
Output power (RMS)	1	1.4	2	1	W

Table 1. Correlation between anti-aliasing filter and output impedance.

Calculating the P.M.P.O.



The energy W_c in a capacitor C with a voltage U_c is given by:

$$W_c = \int_{U_C} Q_c du$$

Where the charge

$$Q_c = CU_c$$

Integrating gives:

$$W_c = \tfrac{1}{2} \cdot CU_c^{\,2}$$

The power is defined as the differential of energy over the differential of time:

$$P = \frac{dW_c}{dt} \quad \text{or} \quad P = \frac{\Delta W_c}{\Delta t}$$

The power dissipated when the voltage on the capacitor falls from the level U_{c1} to the level U_{c2} in the time period Δt is given by:

$$P = \frac{\Delta C(U^2{}_{c1} - U^2{}_{c2})}{2\Delta t}$$

For the Peak Music Power Output "P.M.P.O." Δt is the signal period at 1 kHz, i.e. 1 ms. Generally U_{c1} is the no-load voltage output of the power supply while U_{c2} is the minimum operating voltage of the amplifier output stage (usually equated to zero).